

TWO VIEWS ON REAL-WORLD SKILLS THAT ENGINEERING GRADUATES NEED

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ACADEMIC VS. INDUSTRY PROFESSIONALS: TWO VIEWS ON THOSE REAL-WORLD SKILLS THAT ENGINEERING GRADUATES NEED

Summary of a Panel Discussion about the Role of Hands-On Learning in Colleges

In June 2009, Quanser and The MathWorks co-hosted a lively panel discussion at the American Society for Engineering Education Annual Conference in Austin, Texas: Helping Teach Engineers Real-World Skills With Hands-On Labs.

The panel was composed of practicing academics from engineering departments in American colleges, and representatives from leading engineering firms. (A complete list of panelists can be found at the back of this article.) Given these different worlds, there was much lively debate. However, there was far more agreement than conflict.

Firstly, everyone agreed that the engineers of tomorrow, indeed the engineers of today, need to be cross-disciplined to succeed. They also agreed that hands-on learning, which up-to-date and relevant lab equipment provides, excites and engages students, promoting this integration between disciplines. However Keith Blanchet of Quanser wryly quipped that, while new to some, hands-on learning actually isn't new, quoting Confucius: "I hear, I get; I see, I remember; I do, I understand."

Three themes dominated this lively panel discussion: 1) the emerging necessity of teamwork - that is, integration between engineering and other disciplines, which is so necessary for success in modern product development 2) the role of educators in preparing students for work - or what engineering colleges should be teaching 3) the lack of 'soft skills' and bigger thinking in young engineers - a few warning signs.

Cross-pollination between engineering disciplines an important trend in colleges.

First, the professors talked about courses that offer integration between disciplines and added some interesting notes. Dr. Marcia O'Malley, talked of Rice University's 'Engineering Design Kitchen'. Nine engineering majors share work space and, almost by osmosis, end up learning from each other. "Where these projects used to be squirreled away in corners of every department and every building, now they're in this one facility that's completely open."

The result is a cross-pollination of ideas and confluence of thinking. "They're starting to notice that what that team of civil engineers is doing next to me is not so different than what I'm doing here for my mechanical engineering project, or what those electrical engineers are doing for their project."

The importance of teamwork even goes beyond engineering divisions: Dr. Chaouki Abdallah, talked about the University of New Mexico's 'Integrated Film and Digital Media' program which improbably mixes fine arts and engineering students. An example? In one course, these seemingly divergent students co-design games. "By the end of the semester the students have a competition where a team from gaming companies comes in, and they judge," says Abdallah. "They play the games that were designed during that course and select the best." This is real-life competition and teamwork being used to teach.

O'Malley spoke for all when she summarized: working together and alongside each other is "really getting students to see fewer barriers between disciplines, and I think that's going to help them as they go out into the industry."

Industry prefers students with integrated experience across and beyond engineering disciplines.

Terri Morse of Boeing, Andy Mastronardi of Freescale and Keith Blanchet of Quanser all championed the importance of extra-curricular student competitions. These demand integration between disciplines - not just engineering but marketing, product development, finance, and more. The competitions help establish contacts within industry, while teaching the real-world need for attention to deadlines and budgets.

Morse talked about her personal involvement in "Team Tech, which encourages schools from anywhere that have Society of Women Engineers (SWE) chapters to assemble multidisciplinary teams - at least three disciplines involved in conjunction with an industry partner - on a design and development prototype project that lasts over a six-month time period." The student sees theory turned into practice outside of labs, outside of engineering even, in the real world.

Though exciting and positive, Morse's experience wasn't unique. Mastronardi talked about Freescale's involvement in the ECOCar Competition, another invaluable true-to-life experience practiced by students.

"It used to be more a function of maybe a mechanical engineer, then they pulled in electrical engineering. Now they're starting to pull in all different mathematicians, physicists, as well as people in the business area to market everything. So you get into this interdisciplinary or multidisciplinary type of group, teams of maybe twenty or forty students working on a particular vehicle. Through that activity over a three- or four-year time frame, I think the students become pretty well versed across all of it. They actually build a vehicle, discuss the vehicle, how they're going to market the vehicle, everything about it."

Several panel members talked about the value of co-op programs to both students and companies. Jim Hughes of The Apprentice School of Northrop Grumman Shipbuilding cited Kettering University's Co-op program wherein students' labs, lectures and work are all reinforcing each other - just like Confucius's theory of learning through practice. He applauded how Kettering's courses "integrate multiple disciplines," but especially liked "the range. Some of them are at junior level, some are senior level or a professional level." The students learn real-world knowledge in step with their education. Brilliant!

Earlier in the discussion, Mastronardi of Freescale had observed "a synergy being built between the school, the Faculty, the students, industry. It helps in hiring, because then you can start looking at students from the perspective of who they are, what they're doing, how they carry themselves and those kinds of things." He clearly liked that students are coming into industry with well-rounded skills.

Discussion about the role of engineering educators saw far less agreement.

Panel members disagreed over how this cross disciplinary mega-trend should affect what is being taught. Almost predictably there was a divide between the industry and academic engineers. Both sides tended to see their roles in preparing engineers differently.

Despite her aforesaid enthusiasm for extracurricular competitions, Morse of Boeing felt that current engineering curricula don't offer enough cross-functional experience. "When we talk of interdisciplinary, we don't mean interdisciplinary just between electrical and manufacturing in the

traditional engineering degrees. We mean interdisciplinary between engineering, business finance, marketing, supplier management, project management skills." However graduates still must "get exposure to those cross functional experiences, and bring that to the table to be attractive to us to hire them."

To sum up her point - students need all the skills before entering the workforce. Not surprisingly, this idea faced stirring opposition: "nobody likes to have a generalist," said Abdallah of University of New Mexico. "We want to educate people who have deep knowledge in one, two, or three areas and they can speak the language of the others. The cross-disciplinary part is not somebody who knows about everything."

Professor Mark Spong of the University of Texas at Dallas concurred: "It's not about training one student that knows everything. It's about training students in Electrical and Computer Engineering who can work with mechanical engineers, civil engineers, etc."

Abdallah went further, questioning the supposed responsibility of colleges in creating employees for engineering firms. He felt that students need to be prepared for what's coming decades down the road, not weeks or months. "In many cases we're not 100 per cent aligned to what employers need, or what employers want. In some cases we may not produce the best engineer for Boeing," implying that when a company like Boeing is restructuring, "this person may go and work for GE, or for Sony, and hopefully that's what we're producing - people who are dynamic enough to cross over."

With so much to know, are students missing vital essentials - those 'softer' skills?

While the discussion never became a complaint-fest about 'these kids today', there was concern throughout the room. Too many students are awash in details but missing the big picture. This manifests itself in several ways.

Industry professionals see engineers who aren't considering the final users of products. Blanchet talked about the need for integrated thinking. That is, getting students to consider the implementation process - not just the engineering solution. "If you think about the hands-on process, you have to think about how they are actually going to execute the design, and conceive a system as well. Exposing students to that is also very important."

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At the University of New Mexico, Abdallah sees software whizzes who complete assignments with advanced software without understanding the project. "They never really grasped the concept, but yet they're excellent MATLAB programmers."

Plagiarism is also a growing concern. Abdallah ironically noted how some colleagues "left all their books downstairs, and somebody stole the book on Ethics in Engineering! So that tells you something."

Furthermore, several panel members bemoaned students' inability to express themselves well. Hughes was flagrant on this point: "With the popularity of texting and instant messaging, one of the things that you see today is students losing a lot of their written communication skills. They have to work at it."

In a world where disciplines need to cooperate and integrate, this point seems critical. Abdallah felt that big engineering projects fail because these 'soft skills' aren't well developed. Almost immediately, an audience member challenged him over his use of the phrase 'soft skills'. "They are hard professional skills."

At this stage, O'Malley openly wondered how educators could cram it all in: "How do they do everything in four years and teach them communication skills and technical writing? Because all of this is important!"

Still, it would be unfair to imply that panelists were wringing their hands over the future. In fact there was a great deal of excitement in the room about students and how they're learning by doing. Despite some surmountable shortcomings, everyone sees the future is in good hands.

Indeed, to counter the concerned tone, a couple of panel members noted another bold trend among young people. They want to leave the Earth a better place than they found it and they're not afraid to declare these lofty intentions. They take themselves seriously and expect to be taken seriously too by faculty and industry. Blanchet said they wonder: "How am I going to contribute to society nowadays? So when you're thinking about hands-on education you have to think about how we are going to motivate these students. How are they going to stay within the university system? Are they going to go through the hard times, and come out motivated, and be productive?"

Better engineering professionals start in the college lab.
Blanchet's point about keeping students engaged summarized the discussion neatly. It's clear that preparing young engineers for a life of cross-disciplinary work must begin at college and continue in the real world for life. Shared hands-on laboratories, like Rice University's Engineering Design Kitchen seem the ideal solution. How?

First, students from different engineering disciplines work together or alongside each other, learning integration directly or by observation and shared experience. Second, students learn better by physically conducting real-world experiments, applying the curriculum they learn - consider Confucius's observation about doing. Another benefit? They can also get a solid foundation to enter competitions with their peers. These doses of reality make them much more attractive to employers. And finally, the shared equipment between departments ensures maximum value from colleges' limited funds.

It's a win-win-win!

Quanser and The MathWorks thank all the panelists for their time and contributions to the discussion:

Dr. Chaouki Abdallah - University of New Mexico
Professor and Chair, Electrical and Computer Engineering Department

Keith Blanchet - Quanser Consulting
Director, Business Development

Jim Hughes - The Apprentice School of Northrop Grumman Shipbuilding
Manager, Training

Andy Mastronardi - Freescale Semiconductor
Global Director, Freescale University Programs

Terri F. Morse - Boeing
Director, Engineering, Operations & Technology, Technical Excellence

Dr. Marcia O'Malley - Rice University
Director, Mechatronics and Haptic Interfaces Laboratory

Mark Spang, PhD - University of Texas at Dallas
Professor and Dean, Eric Jonsson School of Engineering & Computer Science

Moderator - Rohit Shenoy - The MathWorks
Academic Technical Evangelist

About Quanser

Quanser is the world leader in education and research-based systems for real-time control design and implementation, providing control challenges for all levels of university education and research.

About The MathWorks

A provider of fundamental tools for engineering and scientific work, The MathWorks' key product, MATLAB, has become a standard in technical computing solutions throughout the world. All Quanser's Control Solutions have been developed to enable customers to quickly and seamlessly connect to Simulink and other MATLAB toolboxes.